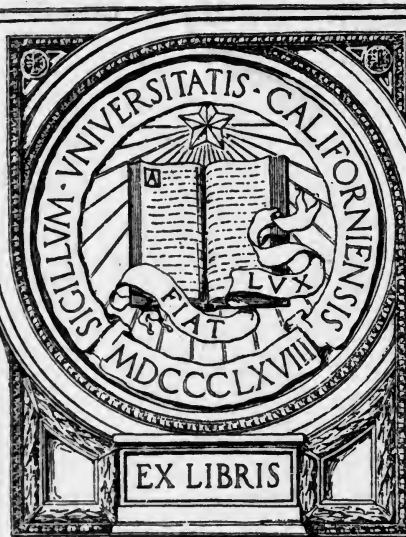


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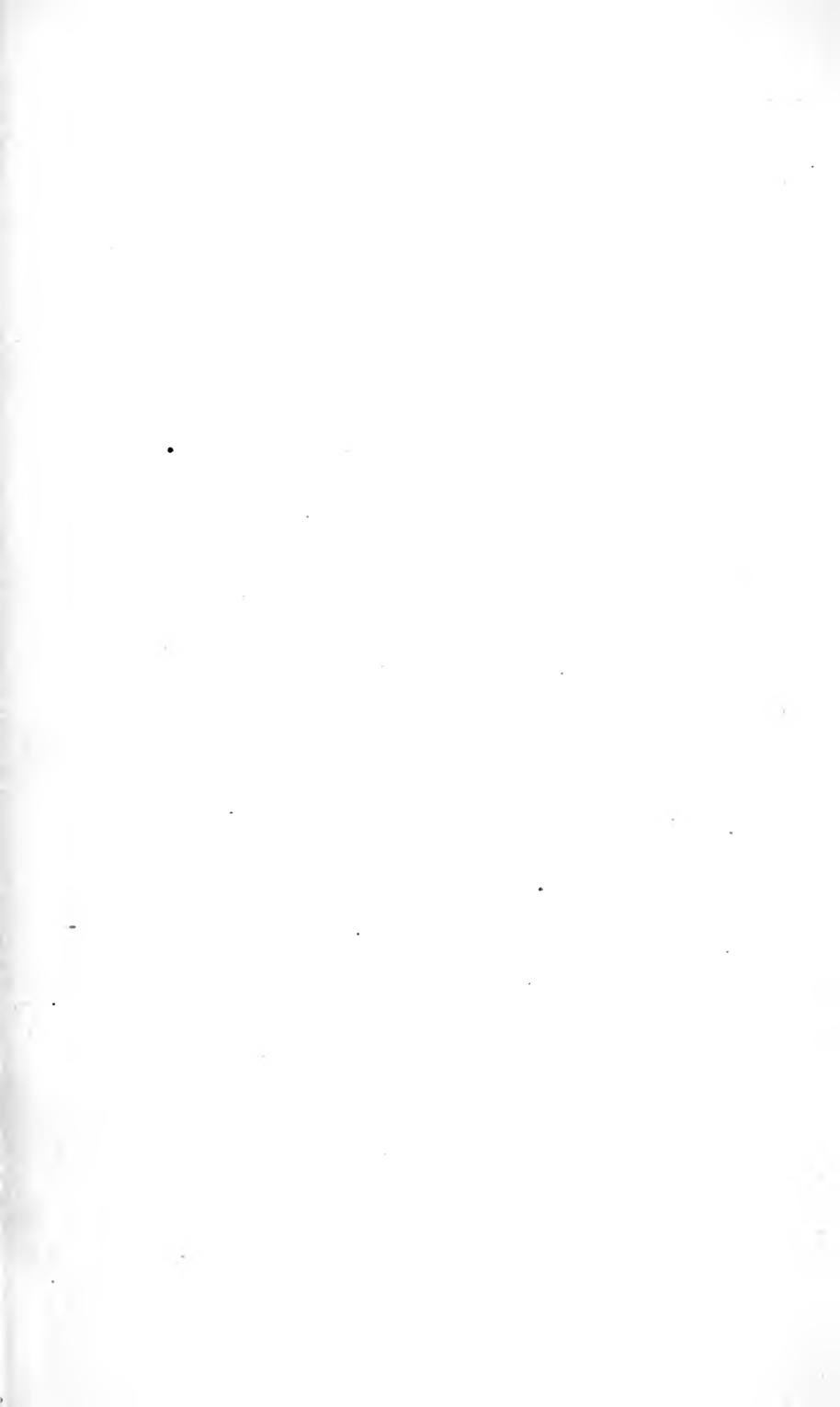
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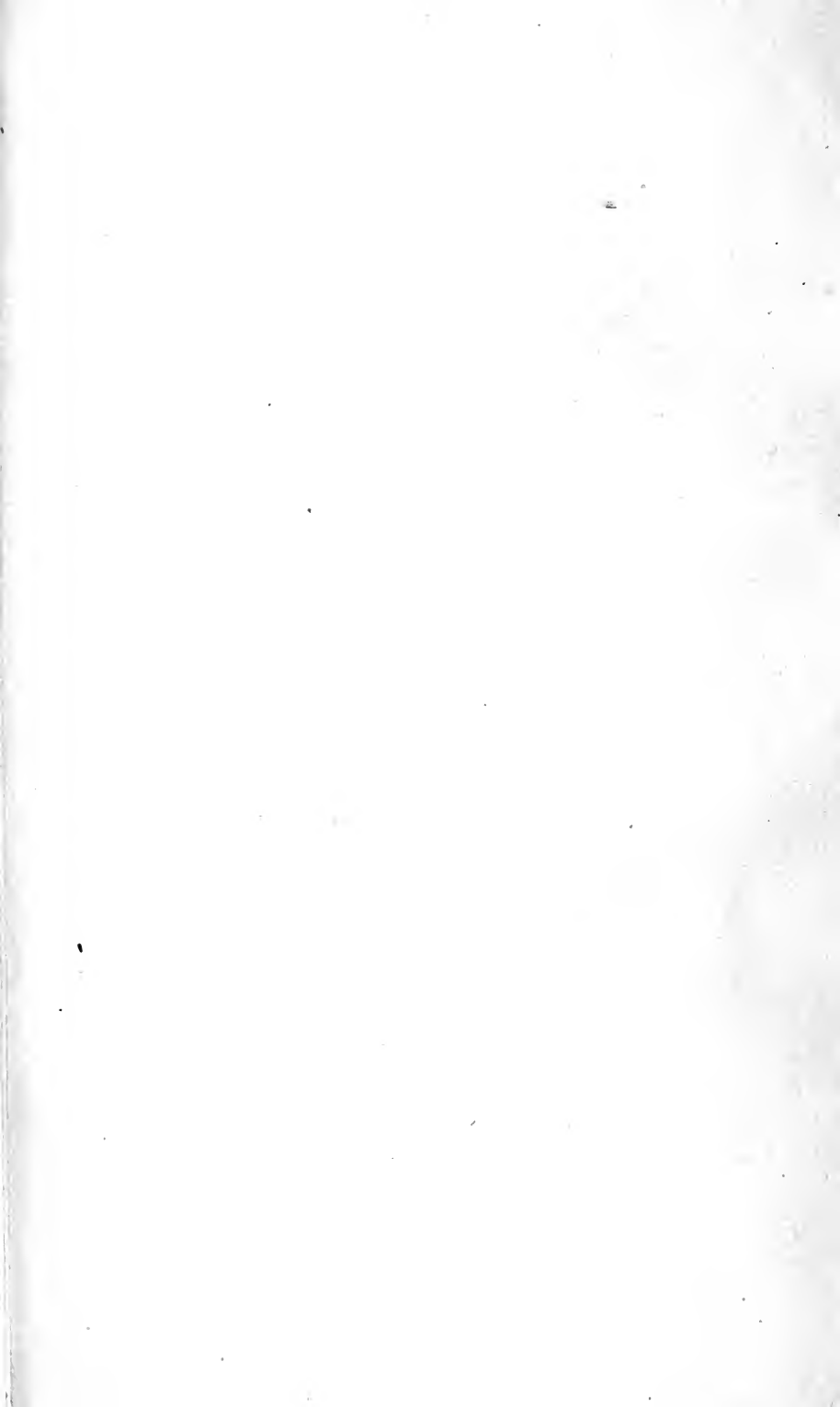


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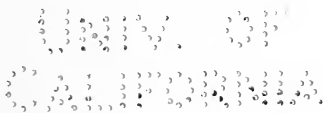
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SEPTEMBER, 1911





ADMINISTRATION  
OF THE OFFICE OF  
RECORDER *of* COOK COUNTY  
ILLINOIS



REPORT PREPARED FOR THE  
JUDGES OF THE CIRCUIT COURT  
BY THE  
CHICAGO BUREAU OF PUBLIC EFFICIENCY  
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Figure 1 shows a 3D plot of 1000 random vectors. The vectors are represented as small arrows originating from a central point, distributed in a spherical pattern. The axes are labeled x, y, and z.

# REPAIRING ASPHALT PAVEMENT

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WORK DONE FOR THE CITY OF CHICAGO  
UNDER CONTRACT IN 1911



A REPORT PREPARED BY THE  
CHICAGO BUREAU OF PUBLIC EFFICIENCY

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OCTOBER, 1911

## **PRIOR PUBLICATIONS**

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- 1 Method of Preparing and Administering the Budget of Cook County, Illinois. January, 1911.
- 2 Proposed Purchase of Voting Machines by the Board of Election Commissioners of the City of Chicago. May, 1911.
- 3 Street Pavement Laid in the City of Chicago: An Inquiry Into Paving Materials, Methods and Results. June, 1911. (Out of print.)
- 4 Electrolysis of Water Pipes in the City of Chicago. July, 1911. (Out of print.)
- 5 Administration of the Office of Recorder of Cook County, Illinois. September, 1911.
- 6 A Plea for Publicity in the Office of County Treasurer. October, 1911.

# REPAIRING ASPHALT PAVEMENT

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WORK DONE FOR THE CITY OF CHICAGO  
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A REPORT PREPARED BY THE  
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900 MASONIC TEMPLE

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## INTRODUCTION

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In 1907 the Legislature of Illinois authorized the collection of a wheel tax in Chicago with the proviso that the money so raised should be expended solely in the maintenance of streets. The amount raised under the wheel tax annually is about \$600,000, and if properly expended should improve the condition and extend the life of pavement in Chicago. The first contract let for this purpose, however, resulted in the wasteful conditions disclosed by the report of the Commission on City Expenditures on the McGovern street repair contract.

The accompanying report on Repairing Asphalt Pavements gives the results of further investigation by the Chicago Bureau of Public Efficiency of the contract for asphalt street repair work for the City of Chicago for the year 1911, and the methods of the contractor in prosecuting the work. The contract itself is analyzed and the work done under it is described and made the subject of comment. The investigation was made by A. J. Hammond, Chief Engineer of the Chicago Bureau of Public Efficiency, and H. J. McDargh, Assistant Engineer.

As streets paved prior to 1906 were covered for the most part by ten-year guarantees of maintenance by the contractor, and those paved since that date by five-year guarantees, streets constructed under both plans must hereafter be maintained by the city, thus causing an increase in the amount of street repair work to be done by the municipality. This situation makes economical and efficient expenditure of the city's street repair fund all the more necessary and important.

CHICAGO BUREAU OF PUBLIC EFFICIENCY.

HERBERT R. SANDS,

*Director.*

October, 1911.





# REPAIRING ASPHALT PAVEMENT

## WORK DONE FOR THE CITY OF CHICAGO UNDER CONTRACT IN 1911

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In this report the subject of repairing asphalt pavements is considered under the following general heads:

- I. Contract and Specifications.
  - II. Excessive Repairs and Non-Compliance with Specifications.
  - III. City's Inspection Still Ineffective.
  - IV. Need for Permanent Records of Repairs.
  - V. Summary and Conclusions.
- 

### I. CONTRACT AND SPECIFICATIONS

On May 6, 1911, bids were received by the Commissioner of Public Works for approximately 100,000 square yards of asphalt street repairs.

The specifications fix a price of \$7 per cubic yard for concrete and \$5 per ton for binder.

The prices charged private parties for the repair of openings in asphalt streets are as follows: The minimum charge for the repair of any opening is \$10. For openings of less than 25 square yards the rate is \$3 per square yard, and for openings of more than 25 square yards the rate is \$2.50 per square yard.

The bids were as follows:

Barber Asphalt Paving Company.....	85 cents per sq. yard
R. F. Conway Company.....	85 cents per sq. yard
Parker-Washington Company .....	69 cents per sq. yard
American Asphalt Paving Company.....	59 cents per sq. yard

The last named company was awarded the contract. It appears that the American Asphalt Paving Company is prac-

tically the same as the old McGovern company. The secretary of this company, W. A. Kenefick, is a brother-in-law of McGovern, and when the company was organized it took over the three McGovern plants. Nine hundred and ninety-eight shares were then issued to Mr. Kenefick. In view of the results obtained under the previous McGovern asphalt paving repair contract, the city should have been placed upon its guard with respect to the letting and enforcement of this contract.

The specifications do not require a minimum temperature for the wearing surface when delivered on the street. The specifications should provide that where the excavation will not permit of at least one inch of binder under the one and one-half inch wearing surface, the repair shall be made with the surface mixture only.

The wearing surface is required to be  $1\frac{1}{2}$  inches thick, except where the combined thickness of the old surface and binder is less than that. Where the combined thickness is in excess of  $1\frac{1}{2}$  inches, a binder may be used.

It is therefore always to the financial advantage of the contractor to use a binder course, and a very thin course is frequently laid, even as thin as  $\frac{1}{2}$  inch. Such a binder can be of little benefit and cannot contain stone up to 1 inch in diameter, as specified. The other alternative is to use a greater thickness of binder and less of the asphalt wearing surface. The asphalt in such cases would be thinner than the contract requires. Observation has proved that this frequently occurs.

In order to avoid the use of an excess of binder, with the consequent thin wearing surface, the bids for wearing surface should be by the cubic foot or by the ton, instead of by the square yard.

This method of payment would permit the use of surface mixture only, where the excavation is too shallow for a one-inch binder under the wearing surface. By measuring or weighing the surface mixture there could be no controversy as to what amount of binder and top should be used, as the con-

tractor would have no object in using an excessive amount of binder and skimping the thickness of the wearing surface. A record of the quantity of wearing surface used can be easily kept and checked with the street measurements.

Competitive bids on binder and concrete might bring lower rates than those fixed arbitrarily in the specifications. Lower prices have been noted in bids of previous years. The price of approximately 34 cents per square yard for binder is very liberal when the contractor is given the privilege of working the old street surface up into binder.

Cuts made for individuals are repaired at the same time the contractor is making a general repair of the street, and the cost of making such a repair should be at no higher rate than that which is paid by the city. Under the prices named in this contract the rate per square yard for a complete paving repair—concrete base, binder and one and one-half inch wearing surface—is \$2.09. On three squares of a recently repaired street there was a total of 200 patches, of which 55 per cent were less than 2.4 square yards each, which, at the above rate of \$2.09, would have made the cost of the greater portion of these repairs less than \$5 each. It therefore seems plausible that the individual is entitled to a reduction from the minimum charge of \$10, and that a minimum price of \$5 could be made with equity.

Public service corporations may make private contracts for their repairs, and the fact that the majority of these cuts are being repaired this year by another company indicates that the prices fixed in the contract for repair of openings are excessive.

## II. EXCESSIVE REPAIRS AND NON-COMPLIANCE WITH SPECIFICATIONS

### *1. Larger Areas Repaired Than Directed by City Inspector.*

Specific instances were noted by Bureau investigators, at the time of repairing Madison street and Clark street, in which the cutting out of the asphalt pavement extended from 6 inches

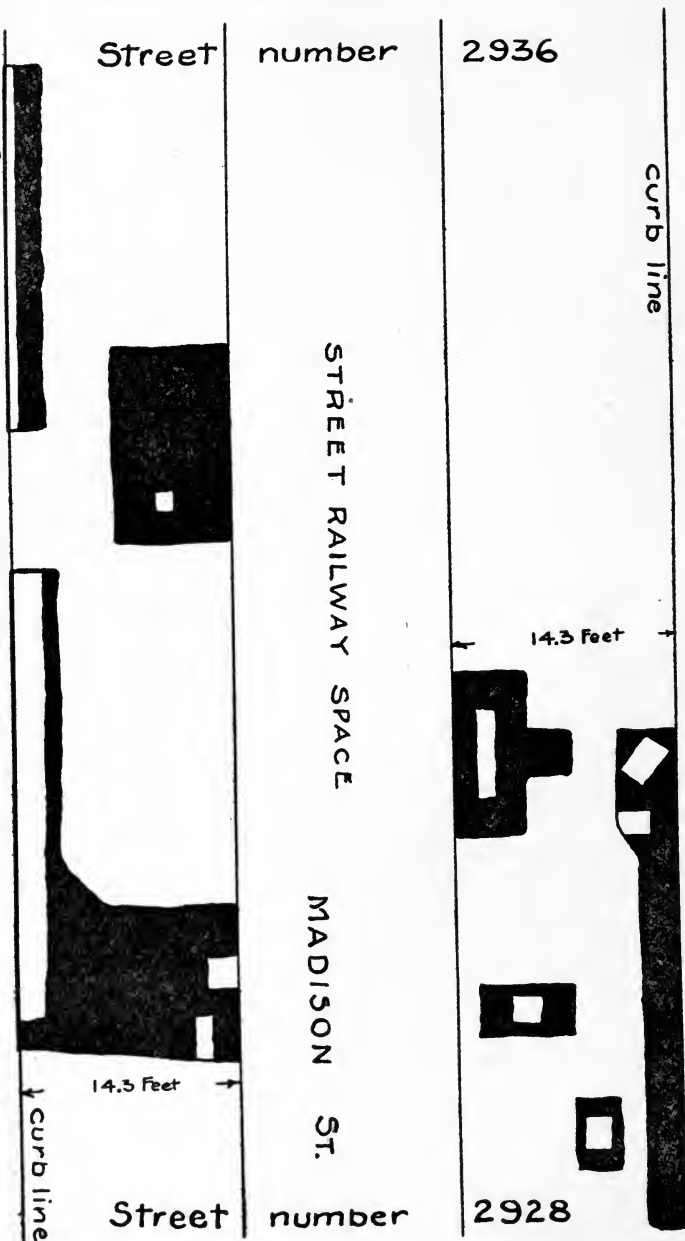


Fig. 1. The small white spaces surrounded by black in the above sketch represent the areas which should have been repaired as estimated by the engineers of the Chicago Bureau of Public Efficiency. The black portions represent the excess of pavement actually repaired.

to 2 feet beyond the lines laid down by the inspector of the city.

Another instance was a series of repairs extending about 3 feet from the curb, with stretches of good pavement between the patches, in which the contractor removed the good pavement, even though it was not marked, and for no obvious reason.

The contractor is given permission to use old asphalt paving mixtures in combination with the binder stone, if crushed and augmented with 1 per cent of asphaltic cement. In removing defective pavement, the cost of removing an additional 6 inches or 2 feet of adjoining good pavement is negligible. This good pavement is hauled to the asphalt plant, worked over, then used as binder in making repairs, and paid for by the city at the rate of \$5 per ton. A great part of the material for binder is thus obtained by the contractor at an exceedingly small cost.

## *2. Faulty Method of Removing Old Pavement.*

In removing defective pavement it is the custom to lift it up with a pick or bar and break it off with the cutter. When the edge of repair is reached this method causes the pavement to be lifted beyond the line as marked by the inspector and destroys the bond between the binder and concrete base. Inspection showed instances where this extended 18 inches beyond the inspector's lines. If the pavement was brittle, cracks developed and unless more pavement was cut out to remove the cracks, moisture would find its way to the concrete base and cause the binder to deteriorate, thus shortening the life of the wearing surface. The loss to the city from the use of such methods is manifest in two ways: First, in the cost of additional area of pavement repaired; second, in the cost of future repairs necessitated by failure of pavement due to such methods. The attention of two street inspectors was called to this faulty method of removing the old pavement, but no remedial steps were taken until the chief inspector was informed. Orders were then issued to cut through the top and binder along the inspector's

line before lifting the old pavement, and this is now being done as far as can be observed.

### 3. *Binder Laid Cold.*

The specifications require that the binder be brought upon the street at a temperature ranging from 200 degrees F. to 325 degrees F. Numerous instances were noted where this binder could be handled with bare hands. On June 13 a load of binder was used on North Clark street which arrived on the work too cold to shovel from the wagon. An effort was then made to dump it, and this was successful after a period of 6½ minutes by using a rake and shovel in pulling it out from below. A large portion of this load was in lumps, and when the binder was distributed the lumps were broken up with rakes and shovels and used as if in the best of condition.

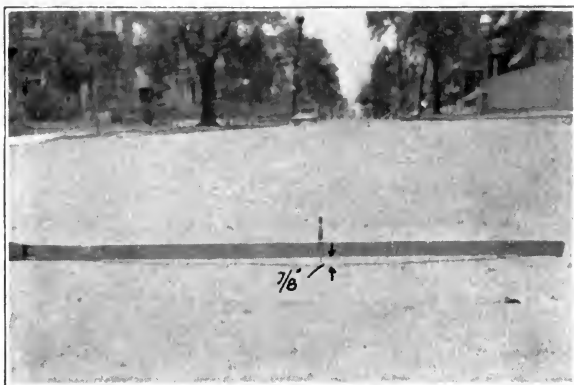
On June 16 a load of binder was unloaded and distributed during a rainstorm, the foreman and inspector standing under an umbrella while the work was being done. When the binder was tamped, water came to the top through the material.

When removing the old pavement the refuse is frequently piled up along the gutter, or either side of the opening, in such manner as to prevent rolling of the binder, as required by the specifications. If the binder is not compressed evenly it results in areas of varying density, and as the top is spread over it evenly and then rolled, there will be places in the repair that are less dense. This will cause depressions in the pavement after a time.

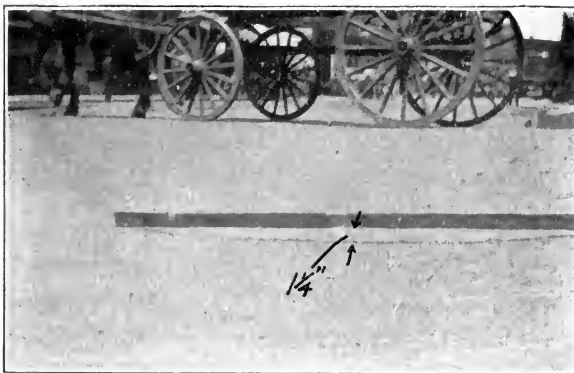
### 4. *Binder Not Covered Promptly With Wearing Surface.*

Unless the binder is covered with the wearing surface within a reasonable period after it is laid, it becomes soiled from traffic and a thin layer of foreign matter forms between the binder and top. The traffic also breaks down the edges of the old pavement, necessitating additional cutting and making a larger area to be paid for.

## Repairing Asphalt Pavement



**Fig. 2.** Prairie Avenue south of Twenty-ninth Street. A 42-inch straight edge laid across the area repaired showed the entire area to be lower than the adjacent pavement. At the center (indicated by arrows) it was  $\frac{7}{8}$  of an inch low.



**Fig. 3.** Clark Street at the intersection with Illinois Street. The binder course on this repair was laid cold and allowed the material to roll which resulted in part of the area being left lower than that adjacent to it. A straight edge laid across the depression showed it to be  $1\frac{1}{4}$  inches deep at the center (indicated by arrows).



**Fig. 4.** Clark Street between Michigan and Illinois Streets. This repair was made on June 17, 1911, and the photo taken on July 24—five weeks later. The binder was laid in wet weather and, being defective, did not afford sufficient foundation for the wearing surface, which soon worked forward and left the concrete base exposed. (See area beneath and to the right of the straight edge.)



**Fig. 5.** Clark Street between Michigan and Kinzie Streets. The above figure shows another result of binder being laid in wet weather. In this case the surface has worked up to the center of the repaired area, causing a depression on either side. A straight edge laid horizontally across the center showed the depressions to be  $1\frac{1}{4}$  and  $1\frac{1}{8}$  inches in depth (the depth is indicated by arrows).



### *5. Thickness of Surface Mixture Less Than Specified.*

The thickness of the top coat of repairs was measured at 370 places on the West Side. Twelve measurements were more than  $1\frac{1}{2}$  inches. Twenty-seven measurements gave a thickness of  $1\frac{1}{2}$  inches, as required under the contract; 331 measurements were less than  $1\frac{1}{2}$  inches and averaged 1.164 of an inch. There were 167 (a little over 50 per cent) 1 inch or less.

On the North Side 336 measurements were taken, of which 27 were more than  $1\frac{1}{2}$  inches, 56 were  $1\frac{1}{2}$  inches, and 253 were less than  $1\frac{1}{2}$  inches, averaging  $1\frac{1}{8}$  inches.

On the South Side 327 measurements were taken, of which 92 were more than  $1\frac{1}{2}$  inches, 70 measurements showed the top to be  $1\frac{1}{2}$  inches thick, and 165 were less than  $1\frac{1}{2}$  inches.

A comparison of these figures will show that the West Side is being given the poorest inspection and the South Side the best.

There are some new repairs where practically the entire area is below the surrounding pavement. In one patch about  $3\frac{1}{2}$  feet square there is a depression of  $\frac{7}{8}$  of an inch. A repair area  $10\frac{1}{2}$  feet long and  $4\frac{1}{2}$  feet wide contained two depressions of 3 square feet each, in which water was standing to the depth of  $\frac{3}{8}$  of an inch. Another repair, 16 feet by 5 feet, had two depressions of 3 square feet each, containing water to a depth of  $\frac{1}{4}$  of an inch.

Two other cases were observed where the whole alley intersection was repaired and water was standing in the gutter line  $\frac{3}{8}$  of an inch deep in one case and  $\frac{1}{2}$  inch in the other.

It has also been noticed that in making repairs around street fixtures which are lower than the surrounding pavement no effort is made to bring the fixture to grade before repairing the pavement.

The pavement in those depressions deteriorates very rapidly, on account of the constant impact of the wheels which may drop into them and the destructive influences exerted by the water they may contain.

6. *Insufficient Mixing, Turning, Raking and Rolling of Surface Mixture.*

The specifications require that the wearing surface "shall be dumped at such distance from the work that all of the mixture must be turned and distributed to the place where it is to be raked."

Inspection by Bureau investigators showed that the wearing surface was shoveled from the wagon to a point as near as possible to where it will be used. The excess amount is raked forward. That portion which strikes the binder first, through its 6-foot fall, is more or less compressed by the weight above it and is given a greater density than that raked forward. When the roller is brought into use it does not compress as much as does the raked material, and an uneven surface is formed. This lack of sufficient mixing, turning and raking is indicated by the uneven and honeycombed condition of the surface after its preliminary rolling. It has been a common occurrence to see the men with smoothing irons working on these small holes in an effort to close them up before the final rolling. If they do not succeed, the traffic will close them, but an uneven surface results. Should the openings remain undisturbed for any length of time, they afford a path for water to reach the binder and cause decomposition of the pavement.

The specifications require that the "initial compression must be effected by means of a small roller," etc. "The final compression shall be effected by a ten-ton roller, or the equivalent of not less than 250 pounds per running inch width." At no time has there been any but the large roller on the work, and should it be placed in use when the material is too hot it causes the mixture to roll, which is difficult to overcome, unless the repair is large enough to allow of diagonal and cross rolling by an experienced mechanic. Should the surface mixture be allowed to become too cool before rolling, the material, when compressed, does not bond properly and a weak pavement results. It is therefore very important that both rollers should be used.

### *7. Lack of Stone in Binder.*

The specifications permit the contractor to crush old asphalt surface paving mixtures and use this material in combination with the binder stone in making binder.

The first inspection made by the Bureau disclosed that the old material was being used, but that no stone was in the binder. It was nothing unusual to find pieces of the old pavement in this binder, showing the careless manner in which it had been prepared. Shortly after regular inspection had been begun by the Bureau, stone was added to the binder, and, in so far as seen, it has been continued up to the present time.

## III. CITY'S INSPECTION STILL DEFECTIVE

In the report on "Street Pavement Laid in the City of Chicago," issued by this Bureau in June, 1911, there was the following comment on city inspection:

"During the inquiry made by this Bureau, it was noted that, in practically all cases, there were enough local and general inspectors on the streets to give adequate supervision and inspection to the construction in progress. That the inspection still remained inefficient in 1910, however, was evidenced by the great number of instances of non-compliance with the specifications which were noted during this investigation. The necessity, already referred to herein, for this Bureau to direct the attention of general inspectors to violations of specifications which should have been obvious to even local inspectors, is further proof that the inspection is bad. The most complete and carefully prepared specifications are rendered futile unless the provisions thereof are enforced by those supposed to protect the interests of the city, and it is of little value to increase the inspection staff without materially improving the efficiency of the force."

The repairs of asphalt streets are under the direct supervision of two city inspectors, one of whom is in charge of marking out the repairs to be made. The other is delegated to inspect the material as it is delivered and used on the street. These two inspectors on each repair gang are under the direction of a general inspector, who supervises the work being done in all parts of the city.

During the early part of the Bureau's inspection it was evident that more pavement was being removed than was actually necessary to secure a workmanlike repair. In order to demonstrate this condition, a length of two blocks was selected on West Madison street, and the engineers of the Bureau estimated the area of the needed repairs, which amounted to 69.5 square yards. Of this amount 14.5 square yards were not removed, which would leave a possible area to repair of 55 square yards. The repairs as made amounted to 255 square yards, which is more than four and one-half times the amount estimated. At the prices submitted the 55 yards would have cost about \$51 and the 255 yards about \$237.

A similar measurement was made on two blocks of Cottage Grove avenue, and it was estimated that it would be necessary to repair 266 square yards and would cost about \$247. There were actually repaired 681 square yards at a cost of about \$632.

In order to corroborate the findings of the Bureau in that more pavement was removed than necessary, similar measurements were made on an asphalt street under reserve. On a stretch of five blocks on Archer avenue it was estimated that there should be 69 square yards of pavement repaired. The contractor actually repaired 37 square yards. When measuring the repairs made, it was noticed that the city inspector had marked out for repairs several places which had also been noted by the Bureau, but the contractor did not remove the same.

Lack of inspection is shown in the manner of removal of old pavement. The contractor was allowed to use methods which destroyed the bond of the good pavement outside of the lines as given by the inspector, and frequently cracked good pavement, which then had to be removed.

The specifications provide at what temperature the binder and top shall be used; but this important requirement, to which attention has been called in a previous report, is not carried out. The inspectors are not provided with thermometers and have

no check on the temperature of the material used. Some of the material used on the street could have been condemned without the use of a thermometer, as it was cold enough to handle with the bare hands. Inattention on the part of the inspector has permitted repairs to be made in which there are depressions of  $1\frac{1}{8}$  inches; other repairs in which the surface is  $\frac{3}{8}$  of an inch above the surrounding pavement, which is very annoying to traffic. The paving in such high repaired areas is subject to early disintegration by the pounding of the wheels of traffic.

The quality of the material, lack of turning, mixing and raking has also been the cause of the wearing surface being finished uneven and in a honeycombed condition.

Lack of inspection is responsible for the wearing surface of a thickness less than  $1\frac{1}{2}$  inches, as required by the specifications. Measurements were made where it was only  $\frac{1}{2}$  inch. It is also responsible for the rolling of the wearing surface, as can be seen on North Clark street, at which point depressions of  $1\frac{1}{2}$  inches are formed, even though this repair has been in use but five weeks.

The specifications require that sufficient binder be placed to fill the opening within one and one-half inches of the top. This would mean an average binder thickness of one and one-half inches, and the weight of this amount of binder would average about 135 pounds per square yard of pavement.

The estimates paid to the contractor show that on Clark street the binder averaged 135.8 pounds per square yard. On Twenty-ninth street the binder averaged 161 pounds per square yard, and on Warren avenue the average was 200 pounds per square yard of pavement. This last average is additional evidence that a greater thickness of binder was used than specified, which resulted in a consequent less thickness of top than required.

The first four estimates granted the American Asphalt Paving Company by the city are based on 21,303.6 square yards of wearing surface, and 3,443,723 pounds of binder furnished.

This makes the binder average 161  $\frac{6}{10}$  pounds per square yard of wearing surface laid.

Observations of a great many repairs have disclosed practically none where the binder and wearing surface exceeded three inches. This maximum depth would therefore require one and one-half inches of binder and one and one-half inches of wearing surface, as called for in the contract.

The excess of binder amounting to 26.6 pounds per square yard would indicate therefore a greater thickness than one and one-half inches, and a consequent less thickness of wearing surface than one and one-half inches. The actual measurements of thickness of wearing surface heretofore noted confirm this statement.

For the estimated amount of asphalt repairs to be laid in 1911, given as 100,000 square yards in the contract, there would be used 2,660,000 pounds, or 1,330 tons, of binder in excess of what should have been used.

The cost of the 1,330 tons excess binder at the contract price of \$5.00 per ton amounts to \$6,650.00.

The thickness of the binder course corresponding to 161.6 pounds of binder per square yard is 1  $\frac{13}{16}$  inches. For a repair which should be 3 inches in thickness, and this is the maximum of the observed places, the top or wearing surface would average only 1  $\frac{3}{16}$  inches in thickness, or  $\frac{5}{16}$  inch less than it should average under the contract.

Estimating the cost of the asphalt wearing surface mixture, delivered in the street, at 55 cents per square yard (the contract being 59 cents laid), the city is paying .1145 cents per square yard for material not furnished, and on the basis of 100,000 square yards of repairs, using the same ratio, the city will have paid in 1911 the sum of \$11,450.00 for asphalt wearing surface not furnished. By adding to this sum \$6,650.00, or the cost of extra binder furnished which replaces the surface mixture, it will be noted that the city will have been overcharged the total sum of \$18,100.00.

#### IV. NEED FOR PERMANENT RECORDS OF REPAIRS

The present method of keeping record of the repairs is not in sufficient detail to locate the repair after being subject to much traffic. It would require but little more time, after taking the size of the opening, to locate it from the curb line, and in the other direction from some established line, such as a building or street. This method would permit the relocating of a repair at any time, and a check could be had on the quality of the work done under different contracts.

#### V. SUMMARY AND CONCLUSIONS

In view of the situation discussed above, the Bureau submits the following recommendations and conclusions in respect to specifications for asphalt repair work and in regard to the inspection of the work done under the contract.

##### I. Specifications—

1. Specifications for asphalt repairs should be so changed as to provide either for one competitive bid on binder per ton, concrete per cubic yard and surface mixture per ton; or
2. The city should fix in the contract a lower rate than \$5 per ton for binder and \$7 per cubic yard for the concrete.
3. The contract should be so changed as to give to citizens the same rate for repairs as is given the city.

##### II. Enforcement of Contract Provisions—

Work done under the specifications is defective in the following particulars:

1. Larger areas of pavement are removed than is necessary.
2. The pavement is damaged by careless methods of cutting out the defective pavement.

3. Often the binder lacks the stone specified in the contract, is laid cold and is not promptly covered with wearing surface.

4. The thickness of the wearing surface is in many instances below the 1½-inch requirement of the contract.

5. The method of mixing, raking and rolling the wearing surface is frequently inadequate to the specified requirements of the contract.

Lack of vigorous and effective inspection of the repair work results in serious loss to the city. It is difficult to estimate this loss accurately, but it is clear that substantially better results might be obtained with a more rigid inspection of the work. More specially trained asphalt paving construction experts should be employed to lay out the areas to be repaired and the contractor should be required to carry out the provisions of the contract.

### III. Records—

In order to test the life of the original pavement and repairs a complete street map, showing the exact location and time of repairs should be kept. Knowledge of the quality of the work done by the repair contractor would be a guide in the letting of future contracts. These records, properly kept and analyzed, would also be valuable in determining at what time the repairs should cease and when the roadway should be resurfaced or repaired.

### IV. Municipal Asphalt Paving Repair Plant—

In view of the difficulty experienced in securing full value for the wheel tax fund expended in street repairs, the Bureau suggests that the city consider seriously whether the work of asphalt paving repairs might not be more economically performed by the city itself.









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